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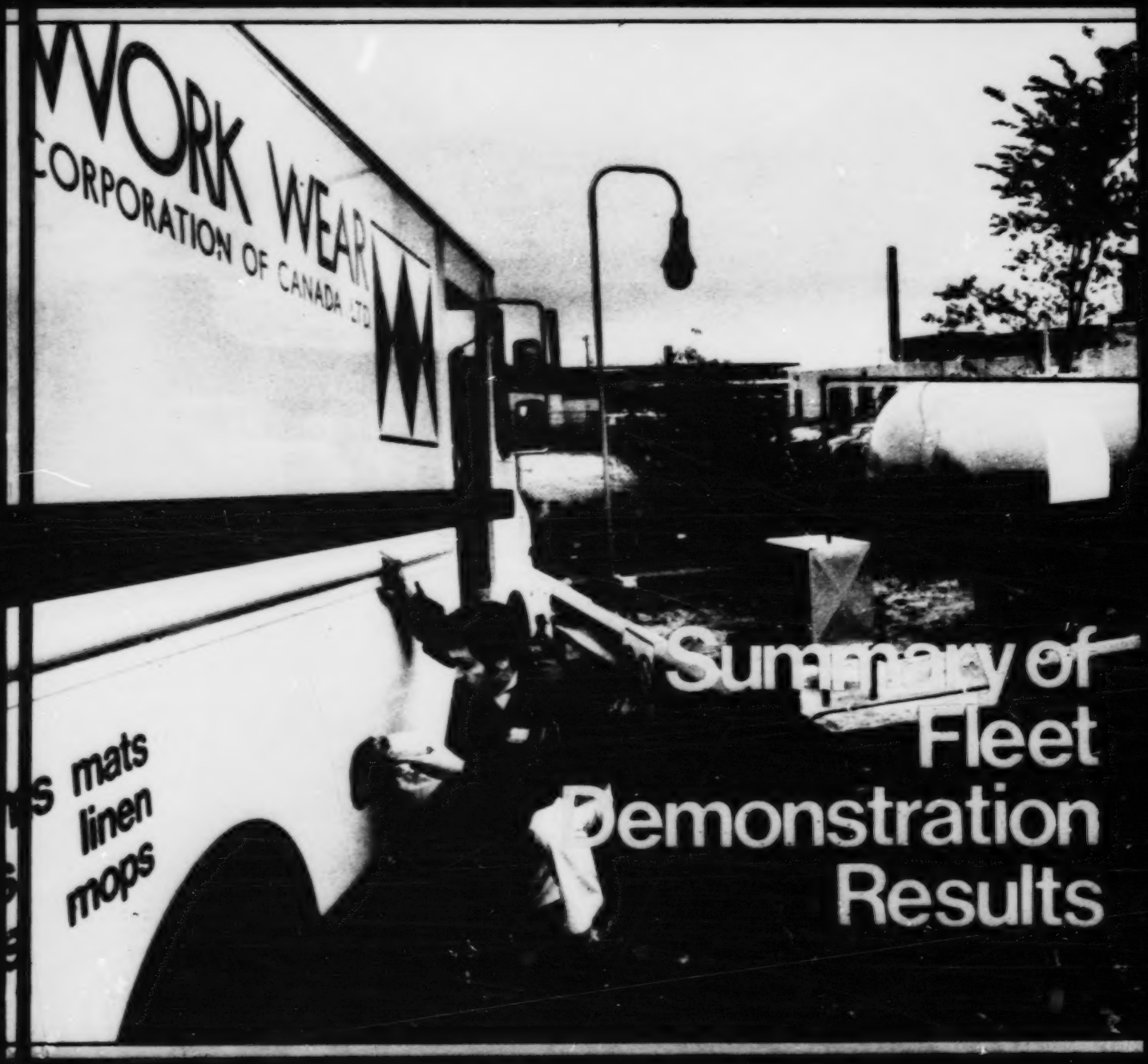

Summary of Fleet Demonstration Results

Drive: Propane

Drive Propane: Summary of Fleet Demonstration Results

Prepared by
IBI Group
Toronto

Prepared for
Drive Propane

Published by:

The Transportation Energy Management Program
The Transportation Technology and Energy Division
Ontario Ministry of Transportation and Communications
Hon. James W. Snow, Minister
H.F. Gilbert, Deputy Minister

In co-operation with
The Ontario Ministry of Energy
Honourable Robert Welch, Q.C., Minister
G.R. Thompson, Deputy Minister

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March 1982

Drive Propane:
Summary of
Fleet Demonstration Results

TABLE OF CONTENTS

	PAGE
EXECUTIVE SUMMARY	iv
1/ INTRODUCTION	1
2/ FLEET PROFILE AND DEMONSTRATION RESULTS	2
2.1/ Aboutown Cars/Aboutown Transit	2
2.2/ AllTrans Express	5
2.3/ Belgoma Transportation Limited	7
2.4/ Bell Canada	10
2.5/ Canada Cartage System	13
2.6/ Canada Post Corporation	16
2.7/ CNX	19
2.8/ Eaton's	22
2.9/ Guelph Red Car	25
2.10/ Hamilton Auto Club	28
2.11/ Hamilton-Wentworth Regional Police Force	31
2.12/ Hostess Food Products Limited	34
2.13/ Maedel's Beverages Limited	37
2.14/ Ministry of Transportation and Communications	40
2.15/ Niagara Regional Police Department	43
2.16/ Regional Municipality of Niagara (Public Works Dept.)	46
2.17/ Purolator Courier Limited	49
2.18/ Shantz Coach Lines Ltd.	52
2.19/ Simpsons-Sears Limited	55
2.20/ City of Sudbury, Public Works Department	58
2.21/ Toronto Star Newspapers Limited	62
2.22/ City of Windsor - Department of Public Works	65
2.23/ Other Fleets Participating in the Demonstration	69

PAGE

3/ ANALYSIS OF DEMONSTRATION PROGRAM PERFORMANCE MONITORING DATA 70
3.1/ Demonstration Program Overview 70
3.2/ Fuel Consumption and Costs 72
3.3/ Summary of Comments on Overall Vehicle Performance . . 74
3.4/ Oil Test Program 78
3.5/ Propane Fuel Tests 80

4/ SUMMARY AND CONCLUSIONS 81
4.1/ Overview 81
4.2/ Summary of Findings and Conclusions on the Performance of Propane-Powered Vehicles in Ontario 82

EXECUTIVE SUMMARY

To reduce both the risk associated with the uncertainties in world oil supply and the flow of Canadian funds out of the country, the Ontario Government is actively pursuing a comprehensive energy conservation and oil substitution program in the transportation, building and industrial sectors of the provincial economy.

Ontario consumes about 250 000 barrels (48 million litres or 10.5 million Imperial gallons) of crude oil each day in transportation. Almost all of this oil comes from outside the province. It is the Ontario Government's goal to help reduce Canada's dependence on foreign oil supplies. Conservation measures such as down-sizing of automobiles and other measures to reduce gasoline and diesel fuel consumption are having an effect. In addition, there is an opportunity to substitute these petroleum-based fuels with domestically-produced alternatives, such as propane, among others.

Propane is produced through the processing of natural gas in the gas fields of western Canada. It is also a by-product of crude oil refining. Currently, about 70 000 barrels of propane a day, considered surplus to domestic needs, are exported to the United States and abroad. The majority of this propane surplus is available through the natural gas liquids fractionation plant in Sarnia.

Prior to the tax incentives announced by the Provincial Treasurer in April, 1980, there was very little experience with propane as a transportation fuel in Ontario -- although propane has been more widely used in the United States, Europe and Japan. Therefore, the Ontario Government set up the Drive Propane Demonstration to assess the fuel's performance in commercial fleet operations throughout the province and reduce overall dependence on crude oil in transportation. This involved monitoring the performance of propane-powered cars and trucks and matching gasoline vehicles in 25 commercial and government fleets, from the Fall of 1980 to December 1981.

The assessment was positive. Fleet operators have found propane to be an excellent alternative to gasoline and, as of March 30, 1982, the fleets participating in the demonstration had a total of 1 200 propane vehicles on the road or on order.

PROPANE ASSESSMENT HIGHLIGHTS

- The average increase in fuel consumption for propane versus gasoline vehicles was 24% (or a 19% drop in miles per gallon).

- As a result of the lower cost of propane fuel, all vehicles in the demonstration recorded lower fuel costs than their gasoline counterparts. The average fuel cost reduction was 28%, or $1 210 per vehicle per year.

- All fleets reported that drivers and mechanics were generally positive about the use of propane vehicles. Many drivers commented on the smoother acceleration and idling of propane vehicles compared with their gasoline counterparts.

- Problems encountered during the demonstration included inaccurate propane fuel gauges, lack of heat, and the noxious odour of the propane fuel. The fuel gauge problem has been dealt with in most fleets by refilling at fixed intervals to avoid running out of fuel The lack of heat problem was solved by experimenting with different thermostats to provide sufficient heat in the interior of the vehicle as well as to the vapourizer/regulator. An odourant is intentionally added to the propane fuel so that it may be detected in the event of a leakage.

- Some early concerns about the safety of the fuel were allayed through actual operating experience. Many fleet managers stressed the importance of education programs to inform drivers and mechanics about the propane fuel system and its safety features.

- Fleet managers have been pleased with the performance of their propane vehicles. In all cases, the propane vehicles have been generally reliable; fulfilling operational duties as well as their gasoline counterparts.

- After one year of experience with a very cold winter, it was demonstrated that cold weather starting with a propane system was generally no more a problem than with gasoline. In exceptional cases, block heaters were installed.

- The results of the demonstration did not provide sufficient evidence on maintenance costs and engine line of a propane-fuelled engine versus a comparable gasoline-fuelled engine. Further monitoring throughout the life of the vehicles will be required to establish these costs.

- Tests on the propane fuel supplied to the demonstration vehicles in a variety of locations throughout Ontario determined that fuel was well within the standard specification for automotive use.

- Although several of the demonstration fleet operators, in consultation with their oil suppliers, increased the engine oil change interval on their propane vehicles over the interval used for their gasoline vehicles, oil tests taken in the demonstration were inconclusive. Further testing and analysis will be required by the major oil companies before general guidelines on oil change intervals for propane-fuelled vehicles can be established.

- At the end of March 1982, it was estimated that 13 000 vehicles were operating on propane in Ontario. This compares with only a few hundred at the beginning of the demonstration program in the Fall of 1981. The Provincial target of 40 000 vehicles on propane by 1985 should, therefore, be achieved in advance of the target date.

- With 40 000 vehicles operating on propane in Ontario, only about 10% of the available surplus of domestically-produced propane will be utilized. The opportunity still remains to convert many more vehicles to propane in Ontario and throughout the rest of Canada.

- It is clear from the results of the demonstration that a well-matched and tuned carburation installation can significantly increase fuel economy. With a proper installation, including tuning under load on a dynamometer, the commercial fleet operator in Ontario should achieve a reduction in costs of 20% to 30% or more at present fuel prices. Payback of the cost of conversion through fuel cost savings in one to three years can also be reasonably expected at current fuel prices. The payback period for the additional cost of a propane fuel system on a new vehicle should be significantly shorter as a result of sales tax savings.

Table 1/ Drive Propane Fleet Demonstration, Summary of Results

- The total number of propane vehicles in the demonstration was 306.
- Fuel consumption and fuel cost comparisons are based on the performance of 145 propane vehicles which had matching gasoline vehicles.
- Fleets participating in the demonstration had a total of 1200 vehicles on the road or on order as of March 30, 1982.

Table 11/ Fuel Consumption and Fuel Cost Comparison
(145 propane vehicles and matching gasoline vehicles)

	PROPANE	GASOLINE	% DIFFERENCE PROPANE vs. GASOLINE
Average fuel consumption of demonstration fleet	37.5 L/100 km 7.53 mpg	30.2 L/100 km 9.35 mpg	+24% -19%
Average annual fuel cost per vehicle - 40 000 km per vehicle - 21¢/L propane - 36¢/L gasoline	$3190	$4400	-28%
Average annual fuel cost savings per vehicle on propane is:	$1210		

1/ INTRODUCTION

The following sections of this report provide:

- A summary table showing the aggregate fuel consumption and annual fuel costs from 145 propane vehicles and matching gasoline vehicles in the demonstration fleets.

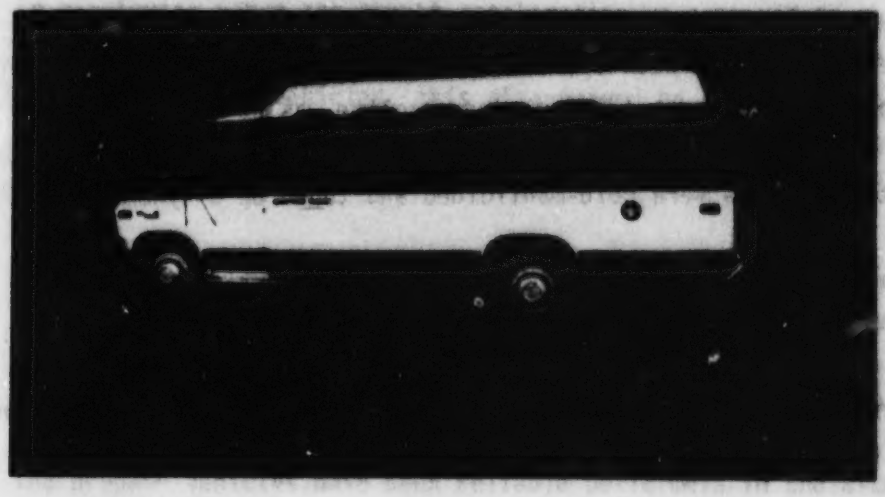
- A summary of preliminary findings and conclusions on the performance of the fuel in the demonstration fleets.

- A technical profile on each of the fleets for which data were collected during the demonstration.

As an Ontario fleet operator you may be considering converting some or all of your fleet to propane. We hope this report will assist you in your decisions on propane fuel.

2/ FLEET PROFILE AND DEMONSTRATION RESULTS

2.1/ ABOUTOWN CABS/ABOUTOWN TRANSIT



2.1.1./ The Fleet

Aboutown operates over 160 vehicles out of its London base. The fleet includes taxis, school bus vans, and commuter vans which operate locally and on scheduled runs from London to the airports at Toronto and Detroit. Almost the entire fleet is now running on propane.

2.1.2/ The Demonstration Vehicles

Group #1

- Four 1980 Dodge B300 Maxivans; 2905 kg (6400 lb) GVW; 5.7 L (360 cid) engine; automatic transmission.
- These vehicles had formerly operated on gasoline for a short time before conversion to propane (distance on gasoline was 60 to 3800 km).
- All four vehicles were cold-manifolded and tuned on a dynamometer.
- The vehicles continue to be used for a mix of city and highway service.
- No comparison gasoline vehicles were available during the demonstration.

Group #2

- Ten 1981 Dodge B350 Maxivans; 5.2 L (318 cid) engine; automatic transmission.

- These vehicles had been operated on gasoline for a short time before conversion to propane (distance on gasoline was 30 to 8600 km).

- All ten vehicles were cold-manifolded and tuned on a dynamometer.

- No gasoline comparison vehicles were available during the demonstration period.

- The vehicles continue to be used for airport service between London and Toronto and London and Detroit.

2.1.3/ Demonstration Period

December 1980 to December 1981

2.1.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Group #1				
Propane Vehicles	26.1	10.8	60 000 km	$ 3290
Gasoline Vehicles	n/a	n/a	n/a	n/a
Group #2				
Propane Vehicles	25.6	11.0	180 000 km	$ 9680
Gasoline Vehicles	n/a	n/a	n/a	n/a

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.1.5/ Fleet Operator's Comment on Overall Performance of the Propane Vehicles

- Drivers have responded positively to the propane vehicles. They have in particular noted the smooth acceleration as compared to gasoline vehicles. Though there was some initial hesitation among the drivers about the propane vehicles, this disappeared once drivers became familiar with the safety and performance characteristics of the propane fuel system.

- The propane vehicles started well in cold weather and, in fact, started more readily than gasoline vehicles in the fleet.

- Maintenance costs appear to be lower for the propane vehicles.

- The propane vehicles have been reliable performers in the high mileage aiport service.

2.1.6/ Future Role of Propane Vehicles in the Fleet

- Aboutown plans to continue expanding the use of propane vehicles in its fleet.

Correspondence concerning the experience of Aboutown Cabs with its propane-powered vehicles should be addressed to:

Mr. W. Vizniowski
24 Horton Street
London, Ontario

2.2/ Alltrans Express

2.2.1/ The Fleet

Alltrans Express is part of the Alltrans Group of Canada, the second largest transport company in Canada. About 100 city trucks operate out of the Alltrans terminal in Mississauga.

2.2.2/ The Demonstration Vehicles

- Eight 12 700 kg (28 000 lb) GVW GMC cab-over trucks; 6.0 L (366 cid) V-8 engines; manual transmission. These trucks were new when converted to propane.

- The conversion to propane included cold-manifolding and timing on a chassis dynamometer.

- Four of the propane trucks were assigned to Vancouver and four remained in Toronto, operating out of the Alltrans yard in Mississauga.

- The four Toronto-based trucks were used primarily in urban delivery service during the period of the demonstration.

2.2.3/ Demonstration Period

October 1980 to December 1981.

2.2.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Propane Vehicles	76.7	3.68	40 000 km	$ 6440
Gasoline Vehicles	n/a	n/a	n/a	n/a

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.2.5/ Fleet Operator's Comments on Overall Vehicle Performance of the Propane Vehicles

- Virtually no problems have been encountered with the propane vehicles.
- Drivers like the smooth acceleration of the propane vehicles.
- The trucks, which are stored outside and have block heaters, have started well in cold weather.

2.2.6/ Future Role of Propane Vehicles in the Fleet

- Three more propane trucks were added to the fleet during the demonstration period. There is a strong possibility that any new city trucks purchased by Alltrans will be propane-powered.

Correspondence concerning the experiences of Alltrans Express with its propane-powered vehicles should be addressed to:

Mr. Don Newsome
Alltrans Group of Canada
5280 Maingate Drive
Mississauga, Ontario
L4W 3S3

2.3/ Belgoma Transportation Limited

2.3.1/ The Fleet

Belgoma Transportation Limited operates a 25-car fleet of Checker cabs in Sault Ste. Marie. As of December, 1981, 20 cars had been converted to propane. All new cars added to the fleet will be propane-powered.

2.3.2/ The Demonstration Vehicles

- Eighteen 1980 Checker taxis; 3.8 L (229 cid) V-6 engines; automatic transmissions.
- All 18 cars had been operated on gasoline before conversion to propane. The engines were not cold-manifolded.
- Four gasoline cars, three of which were converted to propane during the course of the demonstration, were used as comparison units.
- The cars are used as taxis in the City of Sault Ste. Marie, Ontario.

2.3.3/ Demonstration Period

February 1981 to December 1981.

2.3.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Propane Vehicles	24.2	11.7	70 000 km	$ 3560
Gasoline Vehicles	21.4	13.2	70 000 km	$ 5390
% Difference propane vs. gasoline	+13%	-11%		-34%

Annual fuel cost saving with propane is $1830 per vehicle.

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.3.5/ Fleet Operator's Comments on Overall Vehicle Performance of the Propane Vehicles

- Drivers, mechanics, and management have all been extremely pleased with the performance and fuel cost savings of the propane cars. Operational performance has been equal to that of gasoline.

- Spark plug life is longer with the propane vehicles. Oil change intervals have been extended in conjunction with an oil testing program.

- None of the propane vehicles has required replacement of any exhaust system parts. Past experience in this fleet suggests that this is a longer than normal life for exhaust systems.

- The biggest problems early in the demonstration was the inaccuracy of fuel gauges, which resulted in cars running out of fuel. To avoid this problem, cars are now refuelled at the end of every shift.

2.3.6/ Future Role of Propane Vehicles in the Fleet

- **All vehicles added to the Belgoma fleet will be propane-powered.**

Correspondence concerning the experience of Belgoma Transportation Limited with its propane-powered vehicles should be addressed to:

Mr. Paul R. Belanger
General Manager
Belgoma Transportation Limited
73 Brock Street
Sault Ste. Marie, Ontario

2.4/ Bell Canada

2.4.1/ The Fleet

Bell Canada operates 14 000 vehicles in total, with over one-half of these being in the Ontario Region. The vehicles range in size from passenger cars to tracked vehicles and tractors. According to Bell Canada's current plans, about 5% of the company's 7000+ vehicle Ontario fleet could be running on propane by the beginning of 1983.

2.4.2/ The Demonstration Vehicles

- Ten 1978-1980 Dodge B300 vans; 5.2 L (318 cid) V-8 engines; automatic transmissions. These vans were selected from Bell Canada's gasoline-powered fleet and converted to propane. All ten trucks operate out of Bell Canada's Weston yard.

- Propane conversion included installation of cold manifold gaskets and installation of a 160°F thermostat. The first two trucks were converted by the equipment supplier while the remaining eight were converted by Bell Canada's own mechanics.

- One of the trucks was tested on a dynamometer before and after conversion. On gasoline it measured 70 bhp at 50 mph (the engine was tuned to Chrysler specs before the test) and on propane it measured 76 bhp at 50 mph.

- Ten identical gasoline vans operating out of the Weston yard were used as comparison vehicles.

- All 20 vans were operated by the Coin Collection Group during the demonstration and covered the same routes every week. The routes were primarily city driving, with some highway driving between the Weston yard and the starting point of the route.

2.4.3/ Demonstration Period

December 1980 to December 1981

2.4.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Propane Vehicles	30.5	9.3	19 000 km	$ 1220
Gasoline Vehicles	25.3	11.2	19 000 km	$ 1730
% Difference propane vs. gasoline	+20%	-17%		-29%

Annual fuel cost saving with propane is $510 per vehicle.

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.4.5/ Fleet Operator's Comments on Overall Performance of the Propane Vehicles

- Drivers responded positively to the propane-powered vans. The vehicles do not hestitate or stumble while pulling away from a cold start. Some drivers reported improved performance over similar gasoline-powered vans.

- 5 vans stored outside experienced starting problems when the temperatures fell below -15°C. Some of the problems were caused by poor starters or battery cables. Installation of block heaters on these five vans and disconnection of the electrical connection between the starter and the propane converter/regulator eliminated all cold-starting problems.

- Fuel gauges are not accurate.

- Oil in the propane vehicles was not changed during the demonstration, although filters were changed at the normal interval. Oil analysis was performed to monitor condition of the oil.

2.4.6/ Future Role of Propane Vehicles in the Fleet

- Bell Canada has satisfied itself that substantial benefits can be achieved by operating fleet vehicles on propane. Current plans call for about 5% of the company's 7000+ vehicle fleet to be running on propane by the beginning of 1983. This increase in the number of propane vehicles will be achieved through new vehicle purchases rather than conversion of vehicles already in the fleet.

Correspondence concerning the experience of Bell Canada with its propane-powered vehicles should be addressed to:

Mr. P.F. Bieler
Automotive Equipment Manager - T.A.
Bell Canada
83 Signet Drive
Weston, Ontario
M9L 1T6

2.5/ Canada Cartage System Limited

2.5.1/ The Fleet

Canada Cartage System's Ontario Fleet consists of about 600 power units, ranging from light trucks to highway tractor-trailers.

2.5.2/ The Demonstration Vehicles

- Ten 1979 GMC Kurbmasters (14'-16' boxes); 4540 kg GVW (10 000 lb); 5.7 L (350 cid) V-8 engines; manual and automatic transmissions.

- The trucks were selected from Canada Cartage's gasoline fleet and converted to propane. All ten trucks operate out of the Sears Kenmore Distribution Centre in Rexdale.

- Propane conversion was done by Canada Cartage's own mechanics. The engines were cold-manifolded, the ignition timing was advanced, the valve rotators were locked out, and a 160°F thermostat installed. During the winter a 180°F thermostat was installed to increase the output of the heater. The engines were tuned on a chassis dynamometer and an infra-red analyzer.

- Ten gasoline trucks identical to the propane units and operating out of the same facility were used as comparison units.

- All 20 trucks perform similar service, delivering parcels within a 50 km radius of Toronto and involving a mix of city and highway driving.

2.5.3/ Demonstration Period

October 1980 to December 1981.

2.5.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Propane Vehicles	52.2	5.4	25 700 km	$ 2820
Gasoline Vehicles	44.2	6.4	25 700 km	4090
% Difference propane vs. gasoline	+18%	-16%		-30%

Annual fuel cost saving with propane is $1270 per vehicle.

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.5.5/ Fleet Operator's Comments on Overall Vehicle Performance of the Propane Vehicles

- Drivers' comments about the performance of the propane vehicles have been very favourable. They have reported that the propane units have better acceleration than the gasoline units.

- The propane trucks had fewer cold weather starting problems than the gasoline trucks. All the trucks are parked outside in winter.

- In consultation with its oil supplier, Canada Cartage extended the oil change interval on the propane trucks from 5000 km to 10 000 km. Samples of the oil were analysed on a regular basis to ensure that the condition of the oil was at all times satisfatory.

- The tune-up interval for the propane trucks was increased from 13 000 km to 20 000 km. Spark plugs appear to last three times as long as in gasoline units.

- During 1981, the cost of maintenance related to engine and fuel system components was $5252 for the ten propane units and $6945 for the ten gasoline comparison units.

- Overall, the operational performance of the propane vehicles has been equal to that of similar gasoline vehicles.

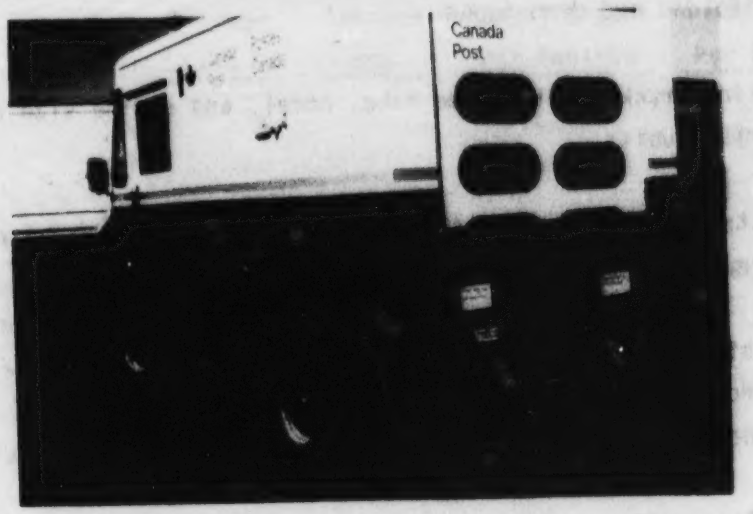
2.5.6/ Future Role of Propane Vehicles in the Fleet

- Any new light vehicles purchased by Canada Cartage will be propane-powered.

Correspondence concerning the experience of Canada Cartage with its propane-powered vehicles should be addressed to:

Mr. Robert B. Hall
Vice-President, Operations
Canada Cartage System Ltd.
1561 The Queensway
Toronto, Ontario
M8Z 1T8

2.6/ Canada Post Corporation



2.6.1/ The Fleet

Canada Post Corporation operates a fleet of almost 4000 vehicles across the country. About 3300 are cars and light trucks, about 400 are medium trucks, and the remaining 60 or so are heavy trucks.

2.6.2/ The Demonstration Vehicles

Group #1

- Two International Harvester Model 1610B cab-over medium trucks; 9900 kg (22 000 lb) GVW; 5.7 L (345 cid) V-8 engines; automatic transmissions.

- Both trucks had been operated on gasoline initially. One truck had travelled 53 500 miles at the time of conversion; the other had travelled 77 000 miles. The engines were cold-manifolded and dyno-tuned.

- Two gasoline trucks of the same make, model, and engine size were used as comparison units.

- All four trucks travel primarily on city roads within the metropolitan Ottawa area.

Group #2

- Two GMC/Chev Model 10542 Step Vans; 2815 kg (6 200 lb) GVW; 4.8 L (292 cid) engines; automatic transmissions.

- Both trucks had been operating on gasoline initially. The engines were cold-manifolded and dyno-tuned.

- Two gasoline trucks of the same make, model, and engine size were used as comparison units.

- All four trucks travel primarily on city roads within the metropolitan Ottawa area.

2.6.3/ Demonstration Period

Group 1 - March 1981 to December 1981

Group 2 - June 1981 to December 1981

2.6.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Group #1				
Propane Vehicles	57.4	4.92	32 000 km	$ 3860
Gasoline Vehicles	42.2	6.69	32 000 km	$ 4860
% Difference propane vs. gasoline	+36%	-26%		-21%

Annual fuel cost savings with propane is $1000 per vehicle.

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Group #2				
Propane Vehicles	36.1	7.82	24 000 km	$ 1820
Gasoline Vehicles	31.6	8.94	24 000 km	$ 2730
% Difference propane vs. gasoline	+14%	-13%		-33%

Annual fuel cost saving with propane is $910 per vehicle.

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.6.5/ Fleet Operator's Comments on Overall Performance of the Propane Vehicles

- Drivers and mechanics have commented favourably on the propane vehicles.

- Some initial driver complaints about lack of power on the IHC units were resolved by tuning the vehicles on a dynamometer.

2.6.6/ Future Role of Propane Vehicles in the Fleet

- Orders have been placed to add 26 additional propane vehicles to the Canada Post fleet. As many as 210 more vehicles could be added during fiscal year 1982-83.

Correspondence concerning the experiences of Canada Post Corporation with its propane-powered vehicles should be addressed to:

Mr. L.E.C. Freeston
Manager, National Fleet Management
Canada Post Corporation
Ottawa, Ontario
K1A 0B1

2.7/ CNX

2.7.1/ The Fleet

CNX operates over 300 trucks in its Ontario pickup and delivery service. The fleet is based at locations throughout southern Ontario: Concord, Pickering, London, Hamilton, Belleville, Ottawa, Brampton, Kitchener and Oshawa. The company currently has 181 propane trucks on the road.

2.7.2/ The Demonstration Vehicles

Group #1

- Three 1976-77 Dodge 16' trucks; 8709 kg (19 200 lb) GVW; 5.2 L (318 cid) V-8 engines; manual transmissions.

- Rebuilt engines were installed in these trucks at the time they were converted to propane.

- Three identical gasoline units were chosen from the fleet to be comparison units.

- All six trucks operate on urban delivery service and are based at CN's yard in northwestern Metro Toronto.

Group #2

- Three 1978 International 1700 Loadstar; 8936 kg (19 700 lb) GVW; 6.6 L (404 cid) V-8 engines; manual transmissions.

- Rebuilt engines were installed in these trucks at the time they were converted to propane.

- Three identical gasoline units were chosen from the fleet to be comparison units.

- All six trucks operate on urban delivery service and are based at CN's yard in northwestern Metro Toronto.

2.7.3/ Demonstration Period

January 1981 to December 1981

2.7.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Group #1				
Propane Vehicles	58.2	4.85	24 000 km	$ 2930
Gasoline Vehicles	Gasoline records are incomplete			
% Difference propane vs. gasoline				
Group #2				
Propane Vehicles	52.5	5.38	24 000 km	$ 2650
Gasoline Vehicles	51.9	5.44	24 000 km	4485
% Difference propane vs. gasoline	+1%	-1%		-41%

Annual fuel cost saving on propane is $1835 per vehicle.

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.7.5/ Fleet Operator's Comments on Overall Vehicle Performance of the Propane Vehicles

- Drivers and mechanics responded positively to the propane vehicles. Initially, some expressed concerns about safety of the propane fuel system. However, these concerns were addressed in a training program. Ninety percent of the CNX mechanics have now completed the S6A training course.

- The propane vehicles have been reliable. Some freeze-up problems were encountered but were caused by improper procedures by drivers. A driver training course has avoided further problems.

- The starting performance of the propane vehicles in cold weather has been equal to and, in some cases, better than similar gasoline vehicles.

- An engine oil test program is being carried out to determine if changes should be made to the current oil change interval time.

- The fleet management's position is that the overall performance of the propane vehicles has been very satisfactory.

2.7.6/ Future Role of Propane Vehicles in the Fleet

- CNX is in the process of converting 20 yard service vehicles to propane.

- Further additions of propane vehicles will be through replacement of existing vehicles.

Correspondence concerning the experience of CNX with its propane-powered vehicles should be addressed to:

Mr. W.G. Stevens
Manager, Automotive Maintenance
Canadian National
800 Dorchester Blvd. W.
Montreal, Quebec
H3B 1X9

2.8/ Eaton's

2.8.1/ The Fleet

Eaton's operates a fleet of about 400 power units in Ontario, ranging in size from cars to highway tractors. At present there are seven propane-powered units in the fleet.

2.8.2/ The Demonstration Vehicles

- Five Ford C700 trucks; 8175 kg (18 000 lb) GVW; 6.1 L (370 cid) engine; manual transmission. These trucks were equipped with the propane fuel system (except the tank) at the factory. All five trucks operate out of the Eaton's garage in Weston.

- One identical C700 truck operating on gasoline served as a comparison unit.

- Both the propane and gasoline units perform delivery service within the Metropolitan Toronto area. A maximum of 50% of vehicle travel is on highways, and the rest is on city streets.

2.2.3/ Demonstration Period

May 1981 to December 1981.

2.8.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Propane Vehicles	73.8	3.83	30 000 km	$ 4650
Gasoline Vehicles	53.0	5.33	30 000 km	5725
% Difference propane vs. gasoline	+39%	-28%		-19%

Annual fuel cost saving with propane is $1 075 per vehicle.

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.8.5/ Fleet Operator's Comments on Overall Performance of the Propane Vehicles

- Drivers have been very happy with the performance of the propane trucks; especially the smooth acceleration.

- The propane trucks have not had any mechanical problems. Spark plugs have not been changed after eight months service and there have been no muffler replacements on the propane trucks.

- The oil change interval has been extended to 12 000 km based on the results of an oil testing program.

- The propane truck whcih recorded the best fuel economy was using, on trial, a distributor designed specifically for use with propane-powered engines.

2.8.6/ Future Role of Propane Vehicles in the Fleet

- Propane vehicles will be given serious consideration for any new vehicle additions to the Eaton's fleet.

Correspondence concerning the experiences of Eaton's with its propane-powered vehicles should be addressed to:

Mr. G. Keindel
Fleet Maintenance Manager
Eaton's
2233 Sheppard Avenue West
Weston, Ontario
M9M 1L6

2.9/ Guelph Red Car

2.9.1/ The Fleet

Guelph Red car operates a Guelph to Toronto airport limousine service with an 8-vehicle fleet of cars and vans.

2.9.2/ The Demonstration Vehicles

Group #1

- One 1981 Oldsmobile Station Wagon; 5.7 L (350 cid) V-8 engines; automatic transmissions.

- This vehicle had operated on gasoline before conversion to propane. It was tuned on a chassis dynamometer after conversion.

- Two 1981 Oldsmobile station wagons and one 1981 Oldsmobile sedan, all with 5.7 L (350 cid) diesel engines were used as comparison vehicles.

- All four vehicles drive almost exclusively on the highway, travelling between Guelph and Toronto International Airport.

Group #2

- Four Dodge vans (2 Maxivans; 2 standard vans); 2 905 kg (6400 lb) GVW; 5.9 L (360 cid) V-8; automatic transmission.

- These vehicles operated on gasoline before conversion to propane. They were tuned on a chassis dynamometer after conversion.

- These four vehicles are also used on Guelph-Toronto airport service. No comparison gasoline vehicles were available in the Red Car fleet.

2.9.3/ Demonstration Period

May 1981 to December 1981.

2.9.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Group #1				
Propane Vehicles	19.5	14.5	180 000 km	$ 7370
Diesel Vehicles	9.2	30.7	180 000 km	6625
% Difference propane vs. diesel	+112%	-53%		+11%

Annual fuel cost on propane is higher by $745 per vehicle.

Note: Using the fleet operator's actual fuel prices instead of the standard prices used here, propane results in a fuel cost saving of about $600 per vehicle.

Group #2				
Propane Vehicles	23.8	11.9	180 000 km	$ 9000
Gasoline Vehicles	n/a	n/a	n/a	n/a

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.9.5/ Fleet Operator's Comments on Overall Performance of the Propane Vehicles

- Drivers find there is essentially no difference in performance between the propane vehicles and gasoline or diesel vehicles.

- The mechanical reliability of the propane vehicles has been excellent. The fleet operator reports maintenance costs are lower with the propane units than similar gasoline units which have been in the fleet.

- Overall, the fleet operator is extremely pleased with the performance of the propane vehicles.

2.9.6/ Future Role of Propane Vehicles in the Fleet

- In future, all vehicles in the Guelph Red Car fleet will be propane-powered, with the exception of limousine sedans which will remain on diesel to avoid giving up trunk space to a propane fuel tank.

2.10/ Hamilton Auto Club

2.10.1/ The Fleet

Hamilton Auto Club operates a fleet of 14 tow trucks in the Hamilton area. Four of the trucks are propane-powered.

2.10.2/ The Demonstration Vehicles

- One 1981 GMC pickup; 4000 kg (8800 lb) GVW; 5.7 L (350 cid) engine; automatic transmission; equipped with tow boom and able to tow vehicles of up to 3630 kg GVW.

- Two identical gasoline trucks were used as comparison vehicles.

- All vehicles in the fleet operate almost exclusively on city streets. In winter 16-hour shifts are common.

2.10.3/ Demonstration Period

December 1980 to December 1981.

2.10.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Propane Vehicles	36.6	7.72	40 000 km	$ 3075
Gasoline Vehicles	35.6	7.94	40 000 km	5125
% Differene propane vs. gasoline	+3%	-3%		-40%

Average annual fuel cost saving on propane is $2 050 per vehicle.

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.10.5/ Fleet Operator's Comments on Overall Performance of the Propane Vehicles

- Fleet management has been pleased with the performance of the propane vehicles. Drivers have also responded positively.

- The trucks are stored outside and are not plugged in, but no starting problems were encountered in cold weather.

- There have been no mechanical problems related to the fuel system.

2.10.6/ Future Role of Propane Vehicles in the Fleet

- Hamilton Auto Club plans to convert more of its towing fleet to propane.

Correspondence concerning the experiences of Hamilton Auto Club with its propane-powered vehicles should be addressed to:

Mr. Larry Smith
The Hamilton Auto Club
393 Main Street East
Hamilton, Ontario
L8N 3T4

2.11/ Hamilton Wentworth Regional Police Force

2.11.1/ The Fleet

Hamilton-Wentworth Regional Police Force operates a fleet of 153 automobiles. At present, 32 of these vehicles are propane-powered.

2.11.2/ The Demonstration Vehicles

- Ten 1981 Mercury Marquis sedans; 5.0 L (302 cid); V-8 engines; automatic transmission. These cars were converted to propane at the time of purchase. They were fitted with 22-gallon tanks mounted in the trunk, with remote fill. The engines were cold-manifolded and tuned on a chassis dynamometer.

- Ten identical 1981 Mercury Marquis operating on gasoline were used as comparison vehicles.

- All 20 cars (propane and gasoline) operate on city police patrols out of the east end detachment in the City of Hamilton. The cars do almost no highway driving. They are driven around the clock and typically have five or six drivers on any given day.

2.11.3/ Demonstration Period

August 1981 to December 1981.

2.11.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Propane Vehicles	34.0	8.31	60 000 km	$ 4285
Gasoline Vehicles	26.0	10.9	60 000 km	5620
% Differene propane vs. gasoline	+31%	-24%		-24%

Average annual fuel cost saving on propane is $1335 per vehicle.

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.11.5/ Fleet Operator's Comments on Overall Performance of the Propane Vehicles

- Performance of the propane vehicles has been excellent. Response from the officers driving the cars have been positive.

- Substantial savings in fuel costs are being realized.

- The inaccuracy of dashboard fuel gauges has required that the vehicles be refuelled every shift in order to avoid running out of fuel.

- No starting problems have been encountered in cold weather. The cars are parked outside and are not plugged in.

2.11.6/ Future Role of Propane Vehicles in the Fleet

- Twenty-two propane-powered Ford LTD II's have been added to the fleet, bringing the propane vehicle total to 32. This total will most probably increase further in future.

Correspondence concerning the experiences of Hamilton-Wentworth Regional Police Force with its propane-powered vehicles should be addressed to:

Staff-Inspector D. Larson
Hamilton-Wentworth Regional Police Force
155 King William Street
Hamilton, Ontario
L8R 1A7

2.12/ Hostess Food Products Limited

2.12.1/ The Fleet

Hostess Food Products Limited operates over 500 vehicles in Ontario. The fleet includes about 400 light trucks, 90 cars and 22 highway tractors. There are now 95 propane vehicles (mostly light trucks) in the fleet.

2.12.2/ The Demonstration Vehicles

Group #1

- Seven 1980 Ford E350 Cutaway vans; 4 600 kg (10 000 lb) GVW; 5.8 L (351 cid); V-8 engines; automatic transmission.

- All seven vehicles were cold-manifolded about halfway through the demonstration period.

- The vehicles operate out of the Hostess garage in Scarborough. All are assigned to regular routes delivering potato chips. Three vehicles travel about 50% on the highway and 50% in the city while the travel split for the remaining four is about 80/20 city/highway.

Group #2

- Three 1980 Chev C30 box trucks, 4200 kg (9250 lb) GVW; 5.7 L (350 cid) engine; automatic transmission.

- Two of the vehicles were cold-manifolded at the time of conversion, the other was done about halfway through the demonstration.

- The vehicles operate out of the Hostess garage in Scarborough. The travel split on regular routes is about 80/20 city/highway for two trucks and 40/60 for the third.

- No gasoline comparison vehicles were available at the Scarborough garage during the demonstration period, but the manager of the Hostess fleet estimates that the propane vehicles get 10 to 12% fewer miles per gallon than they would get on gasoline.

2.12.3/ Demonstration Period

Group 1 - March 1981 to December 1981

Group 2 - June 1981 to December 1981

2.12.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Group #1				
Propane Vehicles	54.9	5.15	18 000 km	$ 2075
Gasoline Vehicles	n/a	n/a	n/a	n/a
Group #2				
Propane Vehicles	45.9	6.15	18 000 km	$ 1735
Gasoline Vehicles	n/a	n/a	n/a	n/a

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.12.5/ Fleet Operator's Comments on Overall Performance of the Propane Vehicles

- The reaction to the performance has been favourable among drivers, mechanics, and fleet management.
- Some starting problems were encountered in cold weather but these were solved by adding block heaters and instructing the drivers in the proper starting procedures.
- Tune-up and oil change intervals have been extended over the intervals for gasoline vehicles.
- New dashboard fuel gauges have been installed and they are giving accurate readings.

2.12.6/ Future Role of Propane Vehicles in the Fleet

- **Current plans call for adding another 60 propane vehicles to the fleet by the end of 1982.**

Correspondence concerning the experiences of Hostess Food Products Limited with its propane-powered vehicles should be addressed to:

Mr. Bert Gilmour
Distribution and Fleet Manager
Hostess Food Products Limited
1001 Bishop Street North
Cambridge, Ontario
N3H 4T7

2.13/ Maedel's Beverages Limited

2.13.1/ The Fleet

Maedel's Beverages Limited is the Pepsi-Cola bottler in Essex and Kent counties. The company operates a 30-vehicle fleet, which is used primarily for the delivery of soft drinks. The fleet is a mixture of light and medium weight class trucks. At present, Maendel's has 9 propane vehicles, 7 of which were part of the Drive Propane demonstration.

2.13.2/ The Demonstration Vehicles

Group #1

- Five Ford LN800 Louisville trucks; 6.4 L and 6.1 L (389 cid and 370 cid) V-8 engines; 5 speed transmissions; 10 440 kg (23 000 lb) 2-speed rear axle, 5450 kg (12 000 lb) front axle.

- These trucks all had been operated on gasoline before conversion to propane (21 000 km to 51 000 km).

- The trucks are used for soft drink delivery. They gross out in the morning from 12 710 kg (28 000 lb) to 15 400 kg (34 000 lb) and gross in at night from 7265 kg (16 000 lb) to 11 350 kg (25 000 lb). Almost all driving is in the city.

- Fuel consumption comparisons are based on the performance of the trucks before they were converted to propane.

Group #2

- Two 1979 Ford F250 pickups; 5.8 L (351 cid) V-8 engines; automatic transmissions.

- Both trucks had been operated on gasoline before conversion to propane (64 000 km and 98 000 km).

- The trucks are driven about 30% on the highway and 70% in the city.

- Fuel consumption comparisons are based on the performance of the trucks before they were converted to propane.

2.13.3/ Demonstration Period

January 1981 to December 1981

2.13.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Group #1				
Propane Vehicles	82.2	3.44	20 000 km	$ 3450
Gasoline Vehicles	61.5	4.59	20 000 km	$ 4430
% Difference propane vs. gasoline	+34%	-25%		-22%

Annual fuel cost saving with propane is $980 per vehicle.

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Group #2				
Propane Vehicles	30.3	9.33	30 000 km	$ 1910
Gasoline Vehicles	23.9	11.8	30 000 km	$ 2580
% Difference propane vs. gasoline	+27%	-21%		-26%

Annual fuel cost saving with propane is $670 per vehicle.

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.13.5/ Fleet Operator's Comments on Overall Performance of the Propane Vehicles

- All seven vehicles performed well after conversion to propane.
- None of the propane vehicles has required maintenance during the demonstration period (except oil and plugs).

2.13.6/ Future Role of Propane Vehicles in the Fleet

- Propane vehicles will be seriously considered for any additions to the Maedel's fleet.

Correspondence concerning the experiences of Maedel's Beverages Limited with its propane-powered vehicles should be addressed to:

Mr. M. Maathuis
Maedel's Beverages Limited
P.O. Box 70
333 Gosfield Townline West
Essex, Ontario
N8M 2Y1

2.14/ Ministry of Transportation and Communications

2.14.1/ The Fleet

The Ministry of Transportation and Communications operates a fleet of 2 745 vehicles based at locations throughout the province. The vehicles range in size from cars up to trucks of 6-ton capacity.

At present, 159 vehicles are propane-powered, and they are spread among 13 locations.

2.14.2/ The Demonstration Vehicles

- A total of 30 vehicles were involved in the demonstration program. Comparison data for two groups of four vehicles are presented below.

Group #1

- Two 1979 Dodge pickups; 2600 kg (5730 lb) GVW; 5.2 L (318 cid) V-8 engine; automatic transmission.

- Both trucks had been operated on gasoline before being converted to propane. Conversion included cold-manifolding, modifications to ignition timing, and tuning on a chassis dynamometer.

- Two identical gasoline trucks were used as comparison vehicles.

- All four trucks operate on highway patrol duty out of the Stratford District.

Group #2

- Two 1979 Ford pickups; 2800 kg (6170 lb) GVW; 4.9 L (300 cid) 6-cylinder engine; automatic transmission.

- Both trucks had been operated on gasoline before being converted to propane. Conversion included cold-manifolding, modifications to ignition timing, and tuning on a chassis dynamometer.

- Two identical gasoline trucks were used as comparison vehicles.

- All four trucks operate on highway patrol duty out of the North Bay District.

2.14.3/ Demonstration Period

December 1980 to December 1981

2.14.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Group #1				
Propane Vehicles	24.6	11.7	64 500 km	$ 3330
Gasoline Vehicles	18.0	15.7	64 500 km	4180
% Difference propane vs. gasoline	+37%	-25%		-20%

Annual fuel cost saving on propane is $850 per vehicle.

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Group #2				
Propane Vehicles	25.5	11.1	79 800 km	$ 4275
Gasoline Vehicles	21.9	12.9	79 800 km	6290
% Difference propane vs. gasoline	+16%	-14%		-32%

Annual fuel cost saving on propane is $2015 per vehicle.

2.14.5/ Fleet Operator's Comments on Overall Performance of the Propane Vehicles

- Drivers' responses to the propane vehicles were generally positive. Some drivers commented that the propane vehicles accelerated more smoothly than the gasoline vehicles and seemed to have more power.

  Some problems encountered in the initial stages of the program were:
  - inadequate range for some northern routes,
  - not enough heat output from the heaters,
  - smell of propane inside the vehicle, and
  - lack of familiarity with refuelling procedures.

2.14.6/ Future Role of Propane Vehicles in the Fleet

Propane dispensing stations have been installed at 15 of MTC's yards. These stations will be able to support expansion of the Ministry's propane fleet above the current 159 vehicles.

Correspondence concerning the experiences of The Ministry of Transportation and Communications with its propane-powered vehicles should be addressed to:

Drive Propane
Ministry of Transportation and Communications
1201 Wilson Avenue
Room 325, Central Building

2.15/ Niagara Regional Police Department

2.15.1/ The Fleet

Niagara Regional Police Department operates a fleet of over 150 vehicles. There are currently 62 propane units in the fleet.

2.15.2/ The Demonstration Vehicles

- Forty 1981 Chrysler Caravelles; 5.2 L (318 cid); V-8 engines; automatic transmissions.
- The vehicles were new when converted to propane.
- Conversion to propane included cold-manifolding, removing exhaust gas recirculation and air pump.
- The vehicles are assigned to police patrol in various parts of the Niagara Region. Vehicle travel is a mix of city and highway driving, but overall city driving is a larger proportion.
- The propane vehicles travelled almost one million kilometres during the nine months of the demonstration program.
- Similar gasoline vehicles were available for comparison.

2.15.3/ Demonstration Period

April 1981 to December 1981.

2.15.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Propane Vehicles	26.0	10.9	88 000 km	$ 4805
Gasoline Vehicles	21.6	13.1	88 000 km	$ 6845
% Difference propane vs. gasoline	+20%	-17%		-30%

Annual fuel cost saving with propane is $2040 per vehicle.

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.15.5/ Fleet Operator's Comments on Overall Performance of the Propane Vehicles

- Officers have responded positively to the propane vehicles.
- The mechanical reliability of the propane units has been excellent, and there have been no problems with the propane fuel system itself.
- There have been no starting problems in cold weather.
- The Department is now in the process of determining if lower engine wear in the propane units will allow the normal trade-in point of 90 000 to 100 000 km to be extended up to 150 000 km.

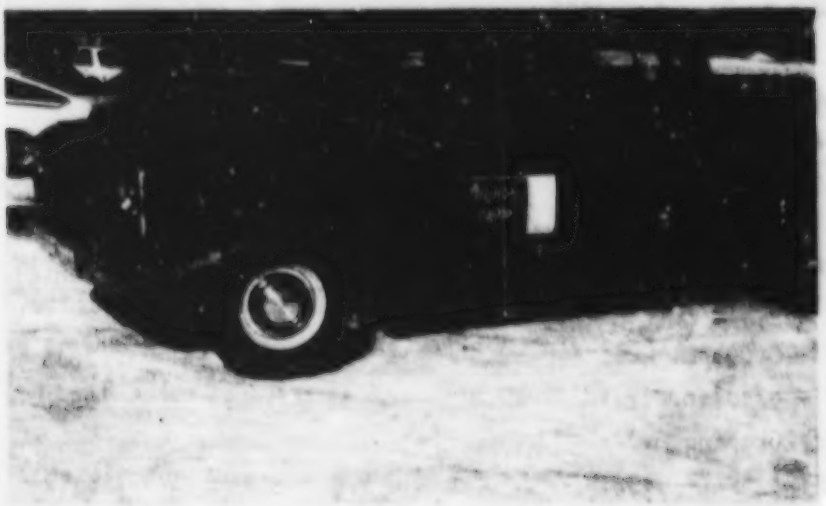
2.15.6/ Future Role of Propane Vehicles in the Fleet

The Department plans to convert 95% of all its patrol and C.I.B. vehicles to propane. About 95 propane units shoiuld be on the road by September 1982.

Correspondence concerning the experiences of Niagara Regional Police Force with its propane-powered vehicles should be addressed to:

Deputy Chief James A. Gayder
Niagara Regional Police Force
68 Church Street
St. Catharines
L2R 3C6

2.16/ Regional Municipality of Niagara (Public Works Department)



2.16.1/ The Fleet

The Public Works Department of the Regional Municipality of Niagara operates a fleet of 184 vehicles, 96 of which are light trucks, 35 are cars and 53 are heavy trucks. The fleet is stationed at over two dozen locations within the 700 square miles of the Region.

2.16.2/ The Demonstration Vehicles

- One 1980 Dodge D262 Crew Cab; 3 882 kg (8550 lb) GVW; 5.2 L (318 cid); V-8 engines; automatic transmission.

- One 1981 Ford LTD Sedan; 5.0 L (302 cid) V-8; automatic transmission.

- Both vehicles had been operated some distance on gasoline before conversion to propane (1900 km and 100 km for the truck and car, respectively).

- An identical gasoline-powered crew cab and a 1980 LTD sedan were used as comparison vehicles.

- The propane-powered crew cab is used primarily for city road maintenance patrol while the comparison unit is used mainly on highway patrol. Both LTD sedans are used for courier service and travel about 80% on the highway.

2.16.3/ Demonstration Period

October 1980 to December 1981

2.16.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Dodge D262 - propane	30.1	9.4	45 000 km	$ 2835
Dodge D262 - gasolene	22.1	12.8	45 000 km	3580
% Difference propane vs. gasoline	+36%	-27%		-21%

Annual fuel cost saving with propane is $745 per vehicle.

Ford LTD - propane	20.3	13.9	58 000 km	$ 2475
Ford LTD - gasoline	15.9	17.8	58 000 km	3320
% Difference propane vs. gasoline	+28%	-22%		-25%

Annual fuel cost saving on propane is $845 per vehicle.

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.16.5/ Fleet Operator's Comments on Overall Performance of the Propane Vehicles

- Driver of the LTD reported that the car started well in all weather, it did not stall on take-off from a cold start and it accelerated smoothly. Drawbacks were the lack of a fast idle for cold weather starts, a slight lack of power in some situations, and the need to install air shocks to compensate for the added weight of the tank in the trunk.
- Driver of the crew cab noted the truck's quiet operation and smooth acceleration. Fuel gauge was inaccurate.

- Mechanics commented that overall performance of propane vehicles is good.

- Analysis of engine oil has shown low metal wear rates for the propane units. Inspection of the engine fo the LTD confirmed this as engine wear was barely visible after 35 000 km.

- The schedule for change of oil and filter and chassis lubrication (preventive maintenance "B") has been changed from every 8000 km to every 16 000 km for the propane units. This is expected to yield a saving of 0.25¢/km.

- The schedule for tune-ups and general vehicle inspection (preventive maintenance "C") remains unchanged at 24 000 km for propane and gasoline units.

- Overall, the Department is satisfied with the performance of the propane vehicles. Although fuel consumption has been higher than expected initially, fuel cost savings have been substantial.

2.16.6/ Future Role of Propane Vehicles in the Fleet

- The Department expects to continue with a propane conversion program if it can overcome certain problems. The major problem seems to be securing a reliable around-the-clock fuel supply, either through commercial outlets or through its own bulk tanks and dispenser units. The problem is largely a result of the Department's 100 light trucks being spread over 24 locations in the region.

Correspondence concerning the experiences of the Regional Municipality of Niagara (Public Works Department) with its propane-powered vehicles should be addressed to:

Mr. R. Howell
Fleet Superintendent, Public Works & Utilities Department
The Regional Municipality of Niagara
P.O. Box 3025, 150 Berryman Avenue
St. Catharines, Ontario
L2R 7E9

2.17/ Purolator Courier Limited

2.17.1/ The Fleet

Purolator Courier Limited operates nationally a fleet of 1500 vehicles, most of which are light trucks engaged in parcel pickup and delivery service.

The company now has 132 propane-powered vehicles in its Ontario fleet and another five in Quebec.

2.17.2/ The Demonstration Vehicles

- Five 1980 Ford E150 Econoline vans; 2800 kg (6170 lb) GVW; 4.9 L (300 cid) 6-cylinder engine; automatic transmission. The vans had been operated on gasoline for about six months before they were converted to propane.

- Converstion to propane included cold-manifolding and a tune-up on a dynamometer.

- Five identical Econolines of the same age and duty cycle were selected as comparison units.

- The ten demonstration vehicles operate out of Purolator's location in Downsview. Their parcel pickup and delivery routes are almost entirely city driving.

2.17.3/ Demonstration Period

April 1981 to December 1981

2.17.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Propane Vehicles	33.3	8.5	32 000 km	$ 2240
Gasoline Vehicles	26.8	10.5	32 000 km	$ 3090
% Difference propane vs. gasoline	+24%	-19%		-28%

Annual fuel cost saving with propane is $850 per vehicle.

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.17.5/ Fleet Operator's Comments on Overall Performance of the Propane Vehicles

- The performance of the propane vehicles has generally been good. Drivers have reported that the propane vans have better acceleration than similar gasoline vans.

- Some drivers were hesitant at first about driving a propane vehicle because of concerns over safety. Operating experience and explanation of the fuel systems have alleviated these concerns.

- Some drivers have complained about the smell of the odorant added to the propane.

- The propane vans, which are parked outside and do not have lock heaters, have experienced more cold weather starting problems than the comparison gasoline units.

- Fuel gauges are inaccurate.

- In co-operation with the fleet's oil supplier, an oil testing program is being conducted to determine the extent to which the oil change interval can be increased.

- More convenient refuelling equipment and procedures are desirable.

2.17.6/ Future Role of Propane Vehicles in the Fleet

- The addition of more propane vehicles to the fleet will be considered based on the performance and fuel cost savings of the 137 propane vehicles now on the road.

Correspondence concerning the experiences of Purolator Courier Limited with its propane-powered vehicles should be addressed to:

Mr. C.E. Moore
National Equipment Manager
Purolator Courier Limited
304 The East Mall, Suite 300
Toronto, Ontario
M9B 6E2

2.18/ Shantz Coach Lines Ltd.

2.18.1/ The Fleet

Shantz Coach Lines operates 80 school vehicles in the Cambridge-Kitchener area. The vehicles range in size from vans to 72-passenger buses. The company currently operates 44 vehicles on propane.

2.18.2/ The Demonstration Vehicles

- The fuel consumption and performance of a variety of propane and gasoline vehicles wre monitored during the demonstration period. The vehicles included Ford E350 vans, Ford B600 school buses, and IHC school buses.

- Identical gasoline vehicles were not available for all propane vehicles. The fuel consumption figures presented in this profile compare the performance of one group of vehicles before and after conversion to propane. These vehicles were assigned to the same routes and drivers throughout the demonstration period. The vehicles are 36-passenger IHC school busses with 5.4 L (330 cid) V-8 engines.

- In all cases propane conversion involved tuning the engine with the vehicle on a chassis dynamometer.

- Vehicles in the Shantz Fleet are generally based at the drivers' residences. Servicing is done at the Shantz garage in Kitchener. Normal operation of the vehicles involves a considerable amount of idling time.

2.18.3/ Demonstration Period

September 1980 to December 1981

2.18.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Propane Vehicles	45.5	6.2	50 000 km	$ 4780
Gasoline Vehicles	38.2	7.4	50 000 km	$ 6880
% Difference propane vs. gasoline	+19%	-16%		-31%

Annual fuel cost saving with propane is $2 100 per vehicle.

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.18.5/ Fleet Operator's Comments on Overall Performance of the Propane Vehicles

- All comments from drivers of the propane vehicles have been favourable.
- There were no mechanical problems with the propane fuel systems during the demonstration period.
- The results of an oil test program have led to a decision to increase the oil change interval for the propane vehicles from 3200 km to 6400 km.

- Generally, cold weather starting has not been a problem with the propane vehicles. Some vehicles are stored where they cannot be plugged in. On extremely cold days propane vehicles have not been any more difficult to start than gasoline vehicles.

- The inaccuracy of the propane fuel gauges has required that fuel log books be kept in all the vehicles.

- Based on its experience over the demonstration period, Shantz Coach Lines recommends that propane vehicles be tuned on a dynamometer. The company reported that in several cases mileage increased 1 mpg (23%) as a result of a dyno check.

2.18.6/ Future Role of Propane Vehicles in the Fleet

- All new buses purchased by Shantz Coach Lines Ltd. will be propane-powered. Gasoline vehicles remaining in the fleet will be converted in all cases in which convenient arrangements for refuelling can be made.

Correspondence concerning the experiences of Shantz Coach Lines Ltd. with its propane-powered vehicles should be addressed to:

Mr. Robert Shantz
Vice-President
Shantz Coach Lines Ltd.
R.R. 21
Cambridge, Ontario
N3C 2V3

2.19/ Simpsons-Sears Limited

2.19.1/ The Fleet

Simpsons-Sears operates a fleet of 3120 vehicles, based in 70 locations across Canada. About 2220 vehicles are power units, ranging in size from cars to highway tractors. The company now has 30 propane-powered units on the road in Ontario.

2.19.2/ The Demonstration Vehicles

- Five 1981 Ford Econoline Vans; 4.9 L (300 cid); 6-cylinder engines; automatic transmission. The vans are fitted with twin 12" x 36" manifold-type tanks with a total capacity of 100 L. All five vans were new at the time of conversion.

- Five identical gasoline-powered Econolines were used as comparison vehicles.

- All ten vans are based at the Sears yard at 2200 Islington Avenue in Rexdale. They are used for delivery and service calls in the Metro Toronto area. The vehicles' routes are a mix of city and highway driving with city driving being the major proportion (about 70% highway).

2.19.3/ Demonstration Period

November 1980 to December 1981

2.19.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Propane Vehicles	28.6	9.9	23 300 km	$ 1400
Gasoline Vehicles	19.8	14.3	23 300 km	$ 1660
% Difference propane vs. gasoline	+44%	-31%		-16%

Annual fuel cost saving with propane is $260 per vehicle.

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

Using Simpsons-Sears actual fuel costs, annual savings per vehicle are, in fact, approximately $500 per vehicle.

2.19.5/ Fleet Operator's Comments on Overall Performance of the Propane Vehicles

- Drivers have been enthusiastic about the performance of the propane-powered vans. They have remarked that the vans start well and idle nicely, and that they have good acceleration in traffic.

- Occasional cold weather starting problems were cured by making sure the block heaters were plugged in when the vehicles were stored outside.

2.19.6/ Future Role of Propane Vehicles in the Fleet

- Sears management has endorsed propane as a good alternative fuel for its fleet operations. The company has demonstrated the substantial fuel cost savings which can be achieved with propane, and over the longer term expects to realize lower maintenance expenses and longer engine life.

- Sears plans to have about 25 propane refill stations installed in Ontario. The number of propane vehicles in the Sears fleet is expected to be about 1000.

Correspondence concerning the experiences of Simpsons-Sears with its propane-powered vehicles should be addressed to:

Mr. S.J. Dawson
Purchasing Agent, Department 806
Simspons-Sears Limited
800 Warden Avenue
Scarborough, Ontario
M1L 4P7

2.20/ City of Sudbury, Public Works Department

2.20.1/ The Fleet

The City of Sudbury Public Works Department operates about 150 vehicles of many different types, from passenger cars to dump trucks, snowplows, and refuse packers.

2.20.2/ The Demonstration Vehicles

Group #1

- Two 1979 GMC ½-ton pickups; 2450 kg (5400 lb); 5.0 L (305 cid); V-8 engines; automatic transmission.

- Propane conversion included cold-manifolding, an increase in ignition timing advance, and switch to a lower temperature thermostat.

- Both vehicles had been operated on gasoline prior to conversion (approximately 18 000 km).

- Six identical gasoline trucks were used as comparison units.

- The propane trucks and the gasoline trucks are used by the supervisors.

Group #2

- Two 1981 Chevrolet Window Vans; 3000 kg (6600 lb); 4.1 L (250 cid); 6-cylinder engines; automatic transmissions.

- Propane conversion included cold-manifolding, an increase in ignition timing advance, and changing from a 195°F to a 180°F thermostat.

- The trucks had run about 200 km on gasoline when converted.

- One truck is used for canine control and the other for survey crew transportation. No similar gasoline rucks were available for comparison.

2.20.3/ Demonstration Period

Group 1 - January 1981 to December 1981

Group 2 - July 1981 to December 1981

2.20.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Group #1				
Propane Vehicles	26.6	10.6	25 000 km	$ 1400
Gasoline Vehicles	20.3	13.9	25 000 km	1830
% Difference propane vs. gasoline	+31%	-24%		-23%

Annual fuel cost saving on propane is $430 per vehicle.

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Group #2				
Propane Vehicles	25.8	10.9	35 000 km	$ 1900
Gasoline Vehicles	-	-	-	-
% Difference propane vs. gasoline	-	-	-	-

No comparison gasoline vehicles available.

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.20.5/ Fleet Operator's Comments on Overall Performance of the Propane Vehicles

- The propane vehicles have performed well. Driver response has been positive.

- The cold start performance of the propane vehicles has been equal to that of the gasoline vehicles. The only problems encountered were unrelated to the propane fuel system.

- No repairs to the propane fuel system have been required.

- The switch to lower temperature thermostats has not resulted in any complaints of inadequate heat in the vehicle interior during winter months.

2.20.6/ Future Role of Propane Vehicles in the Fleet

- During the course of the demonstration, the number of propane vehicles in the fleet has increased to eight. Propane conversion will be seriously considered for all purchases of new vehicles in the light and medium weight classes.

Correspondence concerning the experiences of City of Sudbury Public Works Department with its propane-powered vehicles should be addressed to:

Mr. D. Moran
Mechanical Superintendent
City of Sudbury
P.O. Box 1000 (C.P.)
200 rue Brady Street
Sudbury, Ontario
P3E 4S5

2.21/ Toronto Star Newspapers Limited

2.21.1/ The Fleet

Toronto Star Newspapers Limited operates a fleet of 230 trucks and vans plus 190 cars. About 60 vehicles in the fleet are now running on propane.

2.21.2/ The Demonstration Vehicles

- The fuel consumption and performance of 13 propane vehicles were monitored during the demonstration period. These were a mixture of delivery vans and highway trucks of various makes and engine sizes, including:

- Ford tandem,	8.8 L (534 cid) V-8; 22 800 kg (50 222 lb) GVW
- GM window vans,	4.8 L (290 cid) 6-cyl; 4000 kg (8800 lb) GVW
- IHC	5.7 L (345 cid) V-8; 9200 kg (20 300 lb) GVW
- Ford pickup	4.9 L (300 cid) 6-cyl; 4600 kg (10 100 lb) GVW
- GM cab-over	6.0 L (366 cid) V-8; 14 600 kg (32 200 lb) GVW

All vehicles were cold-manifolded but only three were tuned on a dynamometer.

- All vehicles are used for newspaper delivery, mostly in downtown Toronto and suburbs. Some vehicles are used on highway routes for delivering papers to other towns and cities.

- In almost all cases a matching gasoline vehicle was available for comparison purposes.

2.21.3/ Demonstration Period

June 1981 to December 1981

2,21.4/ Fuel Consumption and Fuel Costs

The data presented here are for 2 propane and 2 gasoline 1978 GM Window Vans; 4.8 L (290 cid); 4000 kg (8800 lb) GVW; automatic transmission (these vehicles were not tuned on a dynamometer when converted to propane).

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Propane Vehicles	41.5	6.81	19 000 km	$ 1655
Gasoline Vehicles	32.5	8.70	19 000 km	$ 2225
% Difference propane vs. gasoline	+28%	-22%		-26%

Annual fuel cost saving with propane is $570 per vehicle.

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.21.5/ Fleet Operator's Comments on Overall Performance of the Propane Vehicles

- There have been no complaints from the drivers about the performance of the propane vehicles.

- None of the propane vehicles has had a mechanical problem related to the fuel system.

- Starting the propane vehicles in cold weather has not been a problem compared with the gasoline vehicles.

- The oil change interval on the propane vehicles has been extended 50% in consultation with the oil supplier.

- Fuel gauge inaccuracy has been a problem.

2.21.6/ Future Role of Propane Vehicles in the Fleet

- New trucks added to the Toronto Star fleet for city delivery service will be propane-powered. Current plans call for about 150 propane vehicles in the fleet by the end of 1982.

Correspondence concerning the experiences of Toronto Star Newspapers Limited with its propane-powered vehicles should be addressed to:

Mr. F.G. Argue
Superintendent of Automotive Transportation
Toronto Star Newspapers Limited
One Yonge Street
Toronto, Ontario
M5E 1E6

2.22/ City of Windsor - Department of Public Works

2.22.1/ The Fleet

The City of Windsor Department of Public Works maintains a 350-vehicle fleet. Vehicles range in size from compact cars to large single-axle dump trucks.

2.22.2/ The Demonstration Vehicles

Group #1

- Four 1980 Chevrolet sedans; 5.7 L (350 cid); V-8 engines; automatic transmissions; air conditioning. The cars had logged about 55 000 km each on gasoline before conversion to propane.

- Before conversion the cars produced about 70 hp (as measured on a dynamometer), and about 60 hp after conversion.

- Four identical gasoline-powered cars were selected as comparison units.

- All eight cars are used as police squad cars on a 24-hour, seven days a week basis. The cars are subjected to extended periods of idling with the air conditioning units in operation.

Group #2

- Three 1981 Ford Fairmonts; 3.3 L (200 cid); 6-cylinder engines; automatic transmissions. These cars were new when converted to propane.

- One identical Fairmont was used as a comparison vehicle. The data on fuel consumption and fuel cost for this vehicle are based on a period during the demonstration when its duty cycle was the same as the propane cars.

- The three propane cars tested out at 42, 43, and 44 hp on a dynamometer, and the gasoline car at 49 hp under the same test conditions.

- The three propane cars are used by the Bylaw Enforcement Department and work two 8-hour shifts per day of start-and-stop delivery-type operation (about 40 stops per day).

2.22.3/ Demonstration Period

March 1981 to December 1981

2.22.4/ Fuel Consumption and Fuel Costs

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Group #1				
Propane Vehicles	30.7	9.2	42 000 km	$ 2710
Gasoline Vehicles	26.1	10.8	42 000 km	$ 3950
% Difference propane vs. gasoline	+18%	-15%		-31%

Annual fuel cost saving with propane is $1 240 per vehicle.

	Average L/100 km	Average mpg	Average Annual Travel Per Vehicle	Average Annual Fuel Cost Per Vehicle
Group #2				
Propane Vehicles	20.7	13.6	30 000 km	$ 1300
Gasoline Vehicles	16.3	17.4	30 000 km	$ 1760
% Difference propane vs. gasoline	+27%	-22%		-26%

Annual fuel cost saving with propane is $460 per vehicle.

Note: Annual fuel costs are based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline. Consequently, the costs stated here may be different than the fleet's actual costs.

2.22.5/ Fleet Operator's Comments on Overall Performance of the Propane Vehicles

- The propane vehicles in both groups have performed well and have shown themselves to be an economical alternative to gasoline.

- Drivers has responded positively to the propane vehicles. The drivers of vehicles in Group #2 favoured the propane cars over the identical gasoline car, which caused the assignment of the gasoline car to other duty.

- Initially, some concern was expressed about driver safety with propane cars in police work. Explanation of the safety features of the propane fuel system relaxed this concern. Two of the propane police cruisers have been involved in traffic accidents. In each case the car was struck and damaged in the area of the propane tank. The tank, piping, or valving did not suffer any damage nor did the presence of the propane equipment make the repairs more difficult.

- No repair work has been required on any component of the propane fuel systems during the course of the demonstration.

- An oil analysis program is being conducted to determine what oil change interval should be used for the propane vehicles. The tests showed that oil condition was satisfactory after 7500 miles. Spark plugs had not been changed after 10 months and inspections show their condition to be satisfactory.

2.22.6/ Future Role of Propane Vehicles in the Fleet

- The City of Windsor Public Works Department has concluded that propane is a safe and when used with suitable operating conditions, an economical substitute for gasoline in its fleet. The City has ordered 32 new vehicles which will be propane-powered, bringing the propane portion of the fleet up to 40 vehicles.

Correspondence concerning the experiences of the City of Windsor Public Works Department with its propane-powered vehicles should be addressed to:

Mr. R. Jacobson
Operations Research and Development Supervisor
City of Windsor
Department of Public Works
Room 302, City Hall,
P.O. Box 1607
Windsor, Ontario
N9A 6S1

2.23/ Other Fleets Participating in the Demonstration

2.23.1/ Northern and Central Gas Corporation

Northern and Central Gas started the demonstration program with four propane-powered trucks. The company now has 88 propane vehicles on the road and more will be added in the coming months.

2.23.2/ Regional Municipality of Durham

The Region's Works Department now has seven propane-powered trucks. Annual fuel cost savings are estimated to be about $350 per vehicle. The Department plans to add six more vehicles to its propane fleet before the end of 1982.

2.23.3/ Simpson's

Simpson's now has 37 propane units on the road out of a total fleet of 230 power units. The propane vehicles are Ford Econolines, GMC Step Vans, and Ford C700 trucks. The C700's had the propane fuel system installed on the assembly line. Performance of the vehicles has been good, and substantial fuel cost savings are being realized.

2.23.4/ Ontario Ministry of Natural Resources

The Ministry of Natural Resources operates 50 propane-powered vehicles in various locations around Ontario. The vehicles have performed well and drivers have reacted positively to them.

3/ ANALYSIS OF DEMONSTRATION PROGRAM PERFORMANCE MONITORING DATA

3.1/ Demonstration Program Overview

The objective of the performance monitoring part of the demonstration program was to collect and analyse performance data of propane vehicles which might help fleet operators decide whether or not to switch to propane. During the late summer and fall of 1980, thirty-two fleet operators who planned to introduce propane vehicles into their fleets agreed to supply performance data for the one-year demonstration period. By February, 1982, 25 fleets had actually managed to submit data for all or part of the demonstration period (December 1980 to December 1981). The other seven fleets were unable to follow through on their intentions, either because of delays in delivery of propane vehicles or data collection problems.

Each fleet participating in the demonstration was asked to provide the following information for both its propane vehicles and matching gasoline vehicles, on a monthly basis:

- fuel consumption and cost;
- servicing interval and costs;
- maintenance, repairs and costs.

In addition, fleet operators were asked to keep records of comments on the overall performance of the propane vehicles relative to their gasoline counterparts.

Several fleets participated in an engine oil testing program aimed at determining the extent to which the oil change intervals for propane vehicles could be extended beyond the interval established for gasoline vehicles.

Exhibit 3.1/ Fuel Consumption and Fuel Cost Comparison (145 propane vehicles and matching gasoline vehicles)

	Propane	Gasoline	% Difference Propane vs. Gasoline
Average fuel consumption of demonstration fleet (L/100 km)	37.5	30.2	+24%
(mpg)	7.53	9.35	-19%
Average annual fuel cost per vehicle	$ 3190	$ 4400	-28%
Average annual fuel cost saving per vehicle on propane is:	$ 1210		

- 40 000 km per vehicle
- 21¢/L propane; 36¢/L gasoline

The 25 fleets taking part in the demonstration submitted data on more than 250 propane-powered vehicles ranging in size from automobiles to medium wight class trucks. The vehicles were used in many different types of duty, including police patrol, parcel pickup and delivery, soft drink delivery, taxi service, highway patrol, and airport limousine service. Gasoline comparison vehicles were available in most fleets.

Of all the types of data collected in the fleet demonstration, fuel consumption and cost assumed the greatest importance. From a fleet operator's point of view, cost savings are the primary reason for switching to propane and fuel costa are by far the largest and also the most immediately realized type of cost saving. Savings which result from extending servicing intervals or from lower maintenance costs for propane vehicles may be significant but are much less important. Also, these cost savings may become apparent only after a length of time substantially greater than the one year period of the demonstration program.

Consequently, the emphasis in this analysis of demonstration program results is given to the fuel consumption and cost results and to a summary of fleet operators' comments on the overall performance of the propane vehicles. Discussion of servicing interval and costs is combined with the analysis of the oil testing program results. The data collected on maintenance, repairs and cost are very limited. They are inadequate to establish the difference in maintenance costs between propane and gasoline vehicles and, therefore, are not presented here.

3.2/ Fuel Consumption and Costs

The aggregate fuel consumption and fuel cost comparisons of propane versus gasoline vehicles are summarized in Exhibit 3.1 (and are presented on a fleet basis in Chapter 2). Two points are immediately apparent from a review of the data:

(1) Propane vehicles consume a greater volume of fuel to travel a given distance than do gasoline vehicles.

(2) Despite consuming a greater quantity of fuel, propane-powered vehicles have annual fuel costs which are substantially lower than gasoline- powered vehicles.

The average of all the percent increases in fuel consumption (i.e., litres per 100 km) for propane versus gasoline vehicles given in Exhibit 3.1 is 24% (which translates into a 19% drop in miles per gallon). The range is quite wide, from a low of 1% to a high of 44%. Since the demonstration program was not a closely controlled test (it was not intended to be), it is not possible to explain this variation in terms of all the factors which might affect fuel consumption. Nevertheless, discussions with representatives of the demonstration fleets and propane carburation specialists pointed to four factors which will help ensure that a propane-powered vehicle achieves the lowest possible fuel consumption. These factors are:

- selection of properly-sized fuel system components to match engine size and loading;

- correct adjustment of ignition timing;

- adequate ignition system voltage, and spark plugs of the proper heat range; and

- final tuning under load on a chassis dynamometer.

In addition, cold-manifolding the engine can have important fuel consumption, benefits for larger vehicles which operate frequently under heavy loads.

Regardless of increases in fuel consumption, all vehicles in the demonstration recorded lower fuel costs than their gasoline counterparts. The average fuel cost reduction was 28% and ranged from 16% to 41%. In dollar terms, the average annual saving was $1210 per vehicle, with a low of $260 and a high of $2100. These fuel costs are based on standard net fuel prices of 21¢/L for propane and 36¢/L for gasoline. Several fleets have had a wider-price gap between propane and gasoline and have thus enjoyed greater savings than the average.

The potential for reducing costs is the single most important factor influencing a fleet operator's decision to switch to propane. Annual fuel costs are determined by a vehicle's rate of fuel consumption rate relative to gasoline and the difference between the prices of the two fuels.

Exhibits 3.2 and 3.3 illustrate fuel cost savings for two different cases. The first case is typical of an automobile or light truck in a fleet of pickup and delivery or service vehicles. The figures in the two columns under the "Propane Vehicle" heading show the difference between a propane vehicle which consumes 15% more fuel than its gasoline counterpart and one which consumes 35% more. The 15% figure is regarded as being a reasonable target for a good propane conversion, whereas the 35% figure is meant to represent a case in which fuel consumption could be reduced by proper tuning and adjustment of the propane vehicle.

Payback periods are calculated using two net conversion costs of $1400 and $700. The $1400 figure is an average cost to convert an existing vehicle, and the second figure applies to conversion of a new vehicle costing $10 000 which saves the fleet operator $700 in Provincial Retail Sales Tax, leaving a net conversion cost of $700.

The figures in the two exhibits demonstrate quite clearly the venefits of a god propane conversion. Fuel cost savings are substantially larger when the propane fuel consumption rate is only 15% greater than gasoline, compared to the savings when the fuel consumption rate is 35% greater than gasoline.

3.3/ Summary of Comments on Overall Vehicle Performance

At the beginning of the demonstration program fleet operators were asked to keep a record of comments from drivers and mechanics on the overall performance of the propane vehicles. Also, comments from a fleet management perspective were invited. The comments from each fleet are given in full in the fleet profiles in Chapter 2, and a general summary and discussion of the most common and important comments is given here.

- General response of drivers and mechanics--By the end of the demonstration period, all fleets reported that drivers and mechanics were generally positive about the use of propane vehicles. Several fleets reported that initial reactions were not positive as a result of concerns about safety. These concerns appeared to arise primarily from a lack of knowledge about propane fuel systems and their safety features. Many fleets addressed these concerns with formal education programs. After drivers and mechanics learned more about propane through such programs and through first-hand experience, initial resistance to the idea of propane vehicles generally seemed to disappear.

Exhibit 3.2/ Fuel Cost Comparison Propane vs. Gasoline, Case 1

	Gasoline Vehicle	Propane Vehicle	
		A	B
Fuel Consumption Rate (L/100 km)	25	28.8	33.8
Annual Travel (km)	$25 000	$25 000	$25 000
Annual Fuel Consumption (L)	6 250	7 200	8 450
Fuel Price (¢/L)	36	21	21
Annual Fuel Cost	2 250	1 510	1 775
Annual Fuel Cost Savings on Propane		740	475
Conversion Cost Payback Period (years):			
- $1400 net conversion cost		1.9	2.9
- $700 net conversion cost		0.9	1.5
Present Value of Annual Savings over 5 years (20% discount rate)		$ 2 215	$ 1 420

Note: A - Fuel consumption rate 15% greater than gasoline
B - Fuel consumption rate 35% greater than gasoline

Exhibit 3.3/ Fuel Cost Comparison Propane vs. Gasoline, Case 2

	Gasoline Vehicle	Propane Vehicle	
		A	B
Fuel Consumption Rate (L/100 km)	50	57.5	67.5
Annual Travel (km)	$40 000	$40 000	$40 000
Annual Fuel Consumption (L)	20 000	23 000	27 000
Fuel Price (¢/L)	36	21	21
Annual Fuel Cost	7 200	4 830	$5 670
Annual Fuel Cost Savings on Propane		2 370	$1 530
Conversion Cost Payback Period (years):			
- $1400 net conversion cost		0.6	0.9
- $700 net conversion cost		0.3	0.5
Present Value of Annual Savings over 5 years (20% discount rate)		$ 7 090	$ 4 575

Note: A - Fuel consumption rate 15% greater than gasoline
B - Fuel consumption rate 35% greater than gasoline

- Driver's view of vehicle performance -- Many drivers commented on the smoother acceleration and idling of propane vehicles compared with gasoline vehicles. Some drivers said the propane vehicles accelerated faster. In a few instances they remarked on a noticeable drop in power on propane. The most frequent complaints by drivers about propane vehicles were:
  - o inaccurate dashboard fuel gauges,
  - o lack of heat, and
  - o odour of propane fuel.

  The inaccurate fuel gauges seem to be an almost universal problem in the demonstration fleets. In some cases no operational problem resulted as the vehicles were routinely filled on a schedule which prevented their ever running out of fuel.

  Running out of fuel was a more common occurrence in fleets which have several drivers operating one vehicle (e.g., police fleets) or which have vehicles that are not assigned regular routes and whose daily mileage can vary widely.

  The lack of heat inside the vehicle was a problem which occurred as a result of a switch to a lower than normal temperature thermostat in the cooling system in order to avoid supplying excessive heat to the converter/regulator. In almost all cases the fleets solved the problem easily by experimenting with different temperature thermostats and selecting one which provided enough interior heat for the driver without sacrificing the effective performance of the fuel system.

  The complaint about the propane fuel odour was reported in a few cases. The odourant added to propane is detectable in very small concentrations, well below the point of there being any safety concern.

- Fleet management's view of propane vehicle performance -- The fuel cost savings have been the single most important feature of the performance of propane vehicles from a fleet manager's point of view. The savings have been substantial, as illustrated in Exhibits 3.1 to 3.3, and in the fleet profiles in Chapter 2. Some fleet managers also expect to realize savings from lower servicing and maintenance costs, but these items will results in smaller benefits than fuel cost savings and also have not been fully documented over the one year demonstration period.

  Operationally, fleet managers have been pleased with the performance of their propane vehicles. In all cases, the propane vehicles have been reliable, fulfilling their operational duties as well as gasoline vehicles. There have been few mechanical problems with the propane fuel systems and most of those which did occur were minor and happened during the early stages of the introduction of propane vehicles into the fleet operations.

  Starting in cold weather was a concern many fleet operators had about propane vehicles at the start of the demonstration. The experience after one year (a year with a very cold winter throughout Ontario) suggests that their performance in this regard is good and is not essentially any better or any worse than gasoline vehicles. Where cold start problems did occur, installation of a block heater was found to be an effective solution. In a few cases, starting problems were partly the result of improper procedures by the drivers. Some fleets have developed a standard procedure for starting and warm-up and have instructed drivers to follow it.

3.4/ Oil Test Program

In conjunction with the demonstration program performance monitoring, several fleets also participated in an engine oil testing program. The purpose of the program was to evaluate the rate at which engine oil deteriorates in propane engines relative to gasoline engines.

The procedure used in the program was to extract the engine oil samples for analysis from both propane-powered vehicles and gasoline-powered control vehicles. It was intended that the oil in the gasoline vehicles would be changed and sampled at the recommended change interval, and that the oil in the propane engine would be sampled, but not changed. The oil in the propane engine would then be sampled and analysed regularly until it had degraded to the same level as that in the gasoline control. The following parameters were used to evaluate the condition of the oil:

- viscosity,
- dielectric constant (an indicator of oil contamination), and
- aluminum and iron content as general wear indicators.

The results of the oil testing program were inconclusive. The variation from vehicle to vehicle for both gasoline and propane vehicles exceeded the variation between gasoline and propane vehicles, particularly for engine wear rates. The analysis also showed a viscosity increase in propane engine oil which was not observed in the gasoline engine oil. This effect could well be due to oil additives designed to combat fuel dilution, a problem which does not occur in propane-fuelled equipment -- propane is present in the engine only as a dry gas; not as a liquid.

Several major oil companies are conducting research on oil deterioration in propane-fuelled engines, but a considerable amount of work is yet to be done before the companies are prepared to make recommendations to the vehicle manufacturers. The vehicle manufacturers themselves have not yet recommended extended oil change intervals for propane-powered vehicles.

The Drive Propane Program is, consequently, unable to recommend that oil intervals be extended as a routine practice at the moment. Several of the fleets involved in the demonstration program are extending their oil intervals based on the results of oil testing, often carried out in conjunction with the fleets' oil suppliers. This should still be regarded, however, as part of the ongoing research effort.

3.5/ Propane Fuel Tests

Propane is generally sold in one of two categories:

- Commercial Propane has a relatively loose specification and is generally used as a heating fuel.
- Motor Fuel Grade Propane has a more restrictive range of properties, which should correspond to one of three accepted specifications:
  1. National Gas Processors Association HD5 specification
  2. American Society for Testing of Materials D 1835 specification "special duty propane"
  3. National Standard of Canada CAN2-3.14M78G Grade 1 Propane.

Though these specifications differ in minor details, they have similar restrictions on propylene content and minimum propane content. For instance, propylene must not exceed 5 liquid volume percent, and a minimum of 90 liquid volume percent must be propane.

Internal combustion engines are especially sensitive to large amounts of propylene content in propane fuels. Propylene causes a large reduction in fuel octane number, which would adversely affect the performance of a propane-fuelled engine.

All of the major propane suppliers in Ontario claim to exclusively supply motor fuel grade propane to their motor fuel customers. Nevertheless, a small test program was carried out to provide independent analysis of propane samples drawn from the bulk storage tanks of fleets participating in the demonstration program. A total of six samples were analysed, all of which exceeded the motor fuel grade specifications. Propane content ranged from 97.7% to 99.2%, while propylene content ranged from being undetectible to a maximum of 0.3%. Two of the samples were obtained in northern Ontario and were of propane supplied by rail car from western Canada. The remaining four samples were from southern Ontario and included one sample of propane produced at an Ontario oil refinery.

4/ SUMMARY AND CONCLUSIONS

4.1/ Overview

Drive Propane was initiated with three principal objectives in mind:

1. To provide information on the performance of propane as a transportation fuel in a cross-section of commercial fleet operations
2. To publicize the results of this demonstration to fleet operators throughout Ontario and to thereby encourage the maximum feasible use of propane as a transportation fuel.
3. To work with manufacturers, suppliers and regulatory agencies to ensure that the necessary requirements for more widespread use of propane are met.

The program has succeeded in achieving these objectives. The enthusiastic response of fleet operators toward the demonstration program was a key factor in this success. Twenty-five fleets participated actively in the program and submitted data on the performance of over 250 propane-powered cars and trucks.

The results of the demonstration program, plus a great deal of general information about propane as a motor fuel in Ontario, were widely publicized through a variety of media. The dissemination of information was guided by a communications plan developed specifically for Drive Propane. Elements of the plan are described in Chapter 1.

Achievement of the third objective involved many difference activities. Members of the Drive Propane project team maintained close contact with the propane industry, vehicle manufacturers, and many other groups through attendance and presentations at association meetings and through many individual discussions. Drive Propane seminars provided another forum for discussion between government representatives, members of the propane industry, vehicle manufacturers, and other interested parties such as the Ontario community colleges. The Drive Propane team played an important liaison role in the development of propane carburation courses at community colleges throughout Ontario.

The most encouraging evidence of the success of the Ontario Government's financial incentives for propane and promotional activities of Drive Propane is the rate at which companies and public sector agencies have added propane vehicles to their fleets. At the end of March, 1982, approximately 13 000 propane-powered vehicles were operating on Ontario's roads. This compares with only a few hundred at the beginning of the demonstration program in late 1980. The province's goal of 40 000 vehicles on propane by 1985 will probably be achieved in advance of the target date.

The amount of gasoline displaced by 13 000 fleet vehicles operating on propane is approximately 100 million litres per year. With the achievement of the 40 000 vehicle target, the annual gasoline displacement will increase to over 300 million litres, which translates to 5200 barrels of gasoline per day. At this level, propane consumption in Ontario transportation will represent less than 10% of the amount by which Canadian propane production exceeds domestic consumption. The opportunity remains, therefore, to convert significantly more vehicles to operate on propane in Ontario and other provinces.

4.2/ Summary of Findings and Conclusions on the Performance of Propane-Powered Vehicles in Ontario

1/ The average increase in fuel consumption for propane versus gasoline vehicles was 24% (or a 19% drop in miles per gallon).

2/ As a result of the lower cost of propane fuel, all vehicles in the demonstration recorded lower fuel costs than their gasoline counterparts. The average fuel cost reduction was 28%, or $1210 per vehicle per year (based on standard fuel prices of 21¢/L for propane and 36¢/L for gasoline).

3 Selection of carburation components which are well matched to a particular engine/vehicle combination and proper installation and tuning are essential if the fleet opeartors are to realize the full financial benefits of a switch to propane. With a proper installation, including tuning under load on a dynamometer, the

commercial fleet operator in Ontario should achieve:

- o an increase in fuel consumption of 15% over gasoline prices;
- o a reduction in costs of 20% to 30% or more at present fuel prices;
- o payback of the cost of conversion through fuel cost savings in one to three years at current fuel prices. The payback period for the additional cost of a propane fuel system on a new vehicle should be significantly shorter as a result of sales tax savings.

4/ Fleet managers have been pleased with the performance of their propane vehicles. In all cases the propane vehicles have been reliable overall and have fulfilled their operational duties as well as their gasoline counterparts.

5/ Fleets switching to propane may encounter some minor operational problems at first. Problems during the demonstration included inaccurate propane fuel gauges, lack of heat, and the noxious odour of the propane fuel. The fuel gauge problem has been dealt with in most fleets by refilling at fixed intervals which ensure that the vehicles do not run out of fuel. Some fleets have also reported that they now have obtained accurate fuel gauges. The lack of heat problem was solved by experimenting with different thermostats to arrive at an acceptable compromise which gave sufficient heat to the vehicle interior but not too much heat to the converter/regulator so as to impair vehicle performance. The odorant added to propane is detectable in very small concentrations well below the point of there being any safety concern. Complaints about the odour were a relatively minor problem.

6/ Experience after one year, with a very cold winter, has demonstrated that cold weather starting is generally no more a problem with a propane fuel system than with gasoline. In a few cases where starting problems did occur, block heaters were installed, which proved to be an effective measure.

7/ Drivers and mechanics are generally positive about the use of propane vehicles. Many drivers in the demonstration program commented on the smoother acceleration and idling of propane vehicles compared with their gasoline counterparts.

8/ Education programs to inform drivers and mechanics about the propane fuel system and its safety features are an important part of a fleet's propane conversion program. Several fleet operators found that some drivers and mechanics were concerned about the safety of the fuel at the beginning of the program, but that these concerns were effectively resolved by an education program and operating experience.

9/ The results of the demonstration did not provide sufficient evidence on maintenance costs and engine life of a propane-fuelled engine versus a comparable gasoline-fuelled engine. Further monitoring throughout the life of the vehicles will be required to establish these costs.

10/ Although several of the demonstration fleet operators, in consultation with their oil suppliers, increased the engine oil change interval on their propane vehicles over the interval used for their gasoline vehicles, oil tests taken in the demonstration were inconclusive. Further testing and analysis will be required by the major oil companies before general guidelines on oil change intervals for propane-fuelled vehicles can be established.